QC 351 T4A
Tech
PUBLIC LIBRARY
NOV 20 1936
DETROIT

U. S. DEPARTMENT OF COMMERCE

Technical News Bulletin

of the

National Bureau of Standards

★ *Issued Monthly* ★

Washington NOVEMBER 1936 Number 235

CONTENTS

Plastics in building construction.
Care of filmslides and motion-picture films in libraries.
Inks for recording instruments.
Standard for testing woven dress fabrics and reporting the results.
Change of volume of rubber on stretching.
Methanol as an antifreeze.
Ebulliometric and tonometric study of normal aliphatic alcohols.
Solubility of mercurous sulphate in sulphuric acid solutions.
Hydrocarbons in petroleum fractions.
Heat of hydrogenation of ethylene.
Refractive index of distilled water as a function of wave length.
Color temperature of tungsten-filament lamps.
Diagram for estimation of chromaticity differences.
Temperature compensation of millivoltmeters.
Redetermination of the atomic weight of aluminum.
Thermal expansion of lead-antimony alloys.
Soil-corrosion studies, 1934.
Talc in whiteware.
Simplified practice recommendation for coarse aggregates.
Revised recommendation covering abrasive grain sizes.
Simplification of hack-saw blades.
New and revised publications issued during October, 1936.
Mimeographed material:
Letter Circulars.
Technical information on building materials.
Recent Bureau articles appearing in outside journals.

PLASTICS IN BUILDING CONSTRUCTION

The following is the abstract of an address by G. M. Kline, chief of the Bureau's section on Organic Plastics, at a meeting of the Federation of Architects, Engineers, Chemists, and Technicians, on October 5, in Washington.

Organic plastics have become familiar to everyone because of the many useful objects fabricated from them which are found in every modern home. Radio housings, French phones, and electrical devices molded of phenol-formaldehyde resin; bright colored clock cases, table accessories and bathroom fixtures of urea-formaldehyde resin; vanity sets and powder containers of cellulose nitrate; lamp shades and pen and pencil sets of cellulose acetate; buttons and buckles of casein—these are but a few of the plastic products which we make use of from day to day.

Plastics now seem destined to find still wider use in the home and in the building industry in general. In laminated form these materials are finding important applications, for interior and exterior trim and several new manufacturing units have been organized recently to meet the growing demand. Installations have been made in theaters, hotel lounges, and bars, banks, and aboard the S. S. *Queen Mary*, and the material is to be utilized on a large scale in the Library of Congress annex at present under construction.

It is of interest, therefore, to consider the method of manufacturing laminated plastics. the advantages which they offer as a building material, and the various purposes for which they have been used.

A laminated plastic is made up of a fibrous filler in sheet form, such as paper, linen, and canvas, and a resin binder, usually of the phenol-formaldehyde type. The individual sheets of

102757—36

filler are impregnated with a solution of the resin, dried, and a sufficient number pressed between steam heated platens in a hydraulic press to give a hard, dense product of the required thickness. Usually a relatively thin sheet of the laminated plastic is applied as a veneer over a less expensive base of pressed board or plywood.

The outstanding advantages which the laminated plastics offer as building materials are superior properties, attractive decorative possibilities, ease of prefabrication, and simplicity of application. The properties which have been of prime importance in the selection of these plastics by architects and builders are their unusual resistance to wear and to corrosion by moisture, acids, alcohols, alkalies, and other deteriorating agents; their excellent mechanical strength; and their dimentional stability. They are available in a practically unlimited range of colors, which go through to the subsurface layers, and the permissible choice of transparent, translucent, mottled, or opaque finishes makes possible a variety of decorative effects. Prefabrication at the factory with no period of seasoning nor additional treatment to resist corrosion are noteworthy features of the material. The simplicity of installation, which requires only one craftsman, a carpenter, and the complete absence of obnoxious odors or of the possibility of chance spotting or staining enables modernization of existing structures to be accomplished during those hours of the day in which the establishment is normally closed.

Many of the applications of laminated plastics can be traced to the smart atmosphere which they create. They have been installed in restaurants, bars, cocktail lounges, department stores, hospitals, and hotels as table and counter tops, for which their warmth, resistance to staining, cigarette-proofness and noise-deadening characteristics are decidedly advantageous. Many theaters, hotels, and banks have used laminated plastics for wall and ceiling panelling because of their attractive appearance, durable finish, and ease of cleaning. The use of laminated plastics for doors achieves both beauty and permanence. Where regulations require fireproof construction, this can be attained without limting the architect in choice of color or design on the face of the door. Exterior applications have not been as extensive as those for interior decoration. However, store-front bulkheads and display signs have been constructed of this material by progressive manufacturers who wished to reach a potential market in which style and smartness would be assets. Resistance to moisture, lack of any tendency to crack because of sudden changes in temperature, and the retention of the original finish indefinitely have been cited as major advantages of the laminated product for such purposes. Architectural uses of laminated plastics in the home and club, office, and public building may be expected to increase rapidly in line with the tendency to modernize surroundings to obtain beauty, simplicity, and utility.

CARE OF FILMSLIDES AND MOTION-PICTURE FILMS IN LIBRARIES

Reference libraries of the future may contain files of photographic films in addition to shelves of the conventional books, if the present tendency to employ this modern method for recording and copying the printed word continues. Hence, it appears that librarians, long the custodians of valuable books and papers, are to be confronted with the problems involved in the care of records on photographic films. Some of these problems have been studied at the Bureau, and a report by C. G. Weber and John R. Hill will be published in the November number of the Journal of Research (RP942).

The film used for records is of the safety type, and is no more flammable than books; hence it offers no new problems in fire protection. It is very stable chemically and should be lasting if properly made and stored. Safety film, however, is quite sensitive to moisture changes and is brittle when dry, satisfactory service requiring that the moisture content be controlled by air conditioning in the storage rooms or vaults.

The ordinary type of motion-picture films have a base of cellulose nitrate which is highly combustible. The storage of this type of film presents difficult problems of fire protection, and should be undertaken only by persons entirely familiar with the necessary precautions.

INKS FOR RECORDING INSTRUMENTS

Instruments for making continuous records of temperatures, steam or barometric pressures, electric voltage, etc., must sometimes go for a long time without attention. The record is made on a circular chart, or on a long roll of paper, and there must be an ample supply of ink of a kind that will not dry and clog the pen. Glycerol

(glycerin) is practically nonvolatile at ordinary temperatures, and it tends to absorb moisture from the air, so it is used for making inks for recording instruments, as well as for rubber stamps. For years, the United States Weather Bureau has used recording inks made by dissolving dyes in a mixture of equal volumes of water and glycerol. Although this mixture is a good "antifreeze", yet there are parts of this country in which it would be frozen solid outdoors during the winter. This is prevented by adding enough alcohol to still further lower the freezing point of the ink. For recording instruments indoors, it is better to make the ink with a mixture of one volume of glycerol and three volumes of water.

Because the glycerol does not evaporate, the ink must dry on paper by being absorbed. The ink not only sinks into the paper, but it also spreads sidewise from the marks made by the pen. If there is too much spreading, the edges of the lines will be uneven or "feathered." Dr. C. E. Waters of the Bureau has recently made tests of a number of recording inks, prepared by dissolving dyes of different types—acid, basic, and direct—in the two mixtures of glycerol and water. The inks were tested by drawing lines with them on five kinds of paper, including the charts regularly supplied with three kinds of recording instruments. After the lines dried, they were rated according to their appearance as nonfeathering, slightly feathering, and decidely feathering.

In all, 190 lines were drawn with 38 inks, made from 19 acid and basic dyes, on 5 kinds of paper. Of these, 72 were rated as decidedly feathering, 108 as slightly feathering, and only 10 as nonfeathering. The proportions of glycerol and water, whether 1:1 or 1:3, made little difference in the results. Sixteen "direct" dyes, which are taken up directly by vegetable fibers, without the aid of mordants to produce insoluble compounds with the dyes, made a far better showing as recording inks. The 32 inks made with these dyes were used for drawing 160 lines on the 5 papers. Of these, 131 were rated as nonfeathering, 22 as slightly, and only 7 as decidedly feathering. Evidently the dyes were taken up by the fibers of the paper before they could get more than a minute distance from the lines as they were drawn.

Ethylene glycol is similar to glycerol in many of its properties, but is somewhat more fluid. Inks were made by dissolving the 16 direct dyes in mixtures of glycerol with 1 and 3 volumes of water. They showed more feathering than the inks made with correspondingly diluted glycerol. With both sets of solvents, the inks containing 3 volumes of water showed the least feathering.

The complete report of these experiments will be found in the November number of the Journal of Research (RP 935).

STANDARD FOR TESTING WOVEN DRESS FABRICS AND REPORTING THE RESULTS

Purchasers who have experienced difficulties with dress fabrics such as fading, shrinking, stretching, and yarns slipping at the seams and have brought these matters to the attention of the retailers, may be largely credited with the increase in laboratory tests on these fabrics both before purchase by retailers and after complaint from the user.

So important had this matter become and so varied have been the test methods employed by commercial laboratories, that the National Retail Dry Goods Association requested the cooperation of the Bureau in establishing a commercial standard covering methods of testing and reporting results of these tests on woven dress fabrics.

The recommended commercial standard, first drafted by a committee of testing laboratory representatives and later adjusted and approved by the general conferences of June 22 and September 27, 1935, has been accepted as the standard practice of commercial testing laboratories, producers, distributors, and users. The standard as established is now available in printed form, as Commercial Standard CS59–36 Woven Dress Fabrics—Testing and Reporting.

It provides nationally recognized methods of testing and reporting results of tests on woven dress fabrics as to breaking strength under atmospheric and wet conditions; color fastness to crocking (rubbing) to cleaning (dry and wet), to drypressing, to laundering and to light; shrinkage in cleaning (dry and wet), and in laundering; and resistance to yarn slippage (resistance to pulling out at seams at points of stress). The methods apply to fabrics comprised of cotton, linen, wool, silk, rayon, and other synthetic fibers, and mixtures thereof.

The standard provides for 6 degrees of fastness to light, 3 of fastness to crocking, 3 of fastness to laundering for cotton or linen fabrics, 1 of fast-

ness to laundering of fabrics composed of silk, rayon, and other synthetic fibers; and 1 of fastness to laundering of wool fabrics, all based on standard dyeings approved by the American Association of Textile Chemists and Colorists.

With the information provided by these tests it should be easy to determine whether a fabric is or is not suitable for a given use.

The pamphlet includes a brief history of the project, a list of official acceptors and the membership of the standing committee. The standard becomes effective as a basis for certification by commercial testing laboratories of compliance with its requirements on April 15, 1936. Copies are obtainable from the Superintendent of Documents, Government Printing Office, Washington, D. C., at 5 cents each.

CHANGE OF VOLUME OF RUBBER ON STRETCHING

When rubber is stretched to a relatively high elongation it undergoes fibering and many of its properties change from those of an amorphous to those of a crystalline material. Previous investigators discovered a time lag in the fibering as indicated by a lag in the development of the X-ray diffraction pattern and the double refraction of stretched rubber. In an investigation by W. L. Holt and A. T. McPherson, the same time lag was found by precise measurements of the change volume on stretching. These results are set forth in RP936 in the November number of the Journal of Research.

When rubber containing no coarse fillers was stretched under ordinary circumstances the volume remained constant up to an elongation of 200 or 300 percent, above which it decreased by an amount which became greater the higher the elongation, the lower the temperature, or the longer the time the rubber was held in the stretched condition. One compound, at an elongation of 600 percent, showed a decrease in volume of 1.2 percent at the end of 1 minute, while after 3 weeks the decrease in volume was 1.8 percent. But even at the end of the 3 weeks the volume was decreasing as a linear function of the logarithm of the time, and gave no indication of approaching a limit.

These observations indicate that Poissons' ratio for rubber, in the absence of coarse fillers, is 0.5 or slightly greater, and depends for its precise numerical value upon the elongation, the temperature, and the time after stretching.

METHANOL AS AN ANTIFREEZE

The National Bureau of Standards does not recommend any particular material for winter use in automobile radiators but gives in its Letter Circular LC28 information regarding the advantages and disadvantages of various solutions which have been used for this purpose. Since methanol has come into much wider use as an antifreeze during the past few years, the following information may be of interest.

Methanol can be obtained from the destructive distillation of wood, or made synthetically. Methanol from wood distillation (formerly called wood alcohol) when refined to meet the specification of the Wood Chemical Institute is satisfactory for radiator use, but the crude product may contain free acids as well as ingredients which attack rubber hose. Synthetic methanol is neutral, non-corrosive, and does not attack rubber.

Wood-distillation methanol containing 23 to 24 percent of water is commonly marketed as "antifreeze methanol", and this material gives about the same protection against freezing as denatured alcohol 188° proof. Undiluted synthetic methanol is readily available under several trade names, and 3 quarts of this product are approximately equivalent to 4 quarts of denatured alcohol.

Although pure methanol boils at a temperature about 25 degrees Fahrenheit below the boiling point of denatured alcohol, the Bureau has found (Ind. Eng. Chem. 23, 708; June 1931) that solutions of the two alcohols which give equal freezing-point protection differ only slightly as to boiling point. There is no evidence that loss of protection due to vaporization is more serious in the case of methanol than in the case of denatured alcohol.

All methanol is poisonous when taken internally, and methanol for antifreeze use is colored with methyl violet for identification purposes. After investigating possible health hazards in connection with this use of methanol, the U. S. Bureau of Mines concluded (Information Circular IC–6415) that "there is no danger of poisoning from the reasonable use of methanol as an antifreeze for automobile radiators." Antifreeze preparations containing methanol bear labels indicating the approximate percentage in accordance

with recommendations of the U. S. Public Health Service.

Most modern antifreeze preparations contain special corrosion inhibitors. These are of two general types: soluble oils, and inorganic inhibitors such as sodium nitrite or borax. The Bureau has not investigated the proportions in which these rust inhibitors are used, or their relative effectiveness.

EBULLIOMETRIC AND TONOMETRIC STUDY OF NORMAL ALIPHATIC ALCOHOLS

A series of normal aliphatic alcohols, including methanol, ethanol, *n*-propanol, *n*-butanol, and *n*-amyl alcohol were prepared in a state of high purity. Their normal boiling points and coefficients of increase of boiling point with increase of pressure were measured by a comparative method using water as a reference liquid. Because of the ebulliometric control of purity of the preparations, the use of substances of high purity, and of the application of the method of comparative measurements, the results were of high precision. The following boiling points, in degrees centigrade, and dt/dp ratios, in degrees centigrade per millimeter of mercury, were obtained.

Methanol—boiling point 64.509°, dt/dp=0.0331;
Ethanol—boiling point 78.325°, dt/dp=0.0334;
n-Propanol—boiling point 97.209°, dt/dp=0.0344;
n-Butanol—boiling point 117.726°, dt/dp=0.0372;
n-Amyl alcohol—boiling point 138.06°, dt/dp=0.0402.

Beginning with *n*-propanol, the introduction of a CH_2 group into the chain of a normal aliphatic alcohol molecule has a specific effect, increasing dt/dp by a constant value of 0.0029, the same amount as in the case of aliphatic hydrocarbons.

The complete report of this investigation by M. Wojciechowski, guest worker from Poland, will be found in RP940 in the November number of the Journal of Research.

SOLUBILITY OF MERCUROUS SULPHATE IN SULPHURIC ACID SOLUTIONS

As part of a program of research on standard cells, which serve as the primary standard of electromotive force, measurements have been completed recently by D. N. Craig, G. W. Vinal, and F. E. Vinal on the solubility of mercurous sulphate in sulphuric acid solutions. The results, which will be found in the Journal of Research for November (RP939), help to interpret some of the conflicting data in the technical literature. They supply for the first time a systematic determination of the effect of temperature on the solubility of this salt.

The determinations were made by an electrolytic method. Each solution was tested after electrolysis for residual mercury. Errors which might arise from the presence of mercuric mercury were shown to be within the limit of experimental error of these determinations. All the solutions were stirred mechanically at fixed temperatures over periods of several days. The concentration of the acid solutions was varied from 0.001 to 4 molar. The paper gives tables for the solubility of the salt in these solutions, the trend of the curves is discussed, and comparisons are made with data previously obtained by others.

HYDROCARBONS IN PETROLEUM FRACTIONS

To complete the study under Research Project 6 of the American Petroleum Institute, of the fraction of a midcontinent petroleum which distilled between 115° and 124° C., the material was distilled and crystallized systematically until practically all of it was concentrated in separate large-volume fractions. To identify or detect their chief constituents, samples of each of these fractions were concentrated further and the physical properties determined.

The material distilling between 116° and 118.5° C. was composed chiefly of paraffinic hydrocarbons with properties not greatly different from the material which had been isolated previously from this range of distillation. The melting point of a mixture of equal volumes of a purified sample from the previous work and of the best sample from the present work was found to lie between those of the individual samples. Photomicrographs also showed distinct similarity of the crystals. It was concluded that both samples were 2-methylheptane or that they were compounds which formed solid solutions with each other.

The refractive index of the material distilling between 119.2° and 120.8° C. indicated that it was chiefly naphthenic. This distillate was divided into three sections and samples of the predominating constituents were concentrated separately. The cooling

curves of samples from the distillate between 119.2° and 119.8°, between 119.8° and 120.4°, and between 119° and 120° in previous work showed similar behaviors. Photomicrographs of the three materials also showed a similarity in behavior of the crystals. The material was thought to be a mixture of dimethylcyclohexanes, and the behavior of the crystals of hydrogenated *m*- and *p*-xylenes were studied for comparison. The hydrogenated *m*-xylene showed long plate-like crystals with tendencies to grow frond-like structures. Such crystals may have been present in the samples mentioned above but were more definitely visible in the sample from the distillate bebetween 120.4° and 120.8°. None of the characteristic *p*-dimethylcyclohexane crystals was visible in any of the samples from petroleum. It was concluded that the petroleum contained *m*-dimethylcyclohexane and another naphthene not yet identified.

The material distilling between 122° and 124° was also highly naphthenic. The properties of a purified sample from this distillate showed that it might be trans-*o*-dimethylcyclohexane. A combustion analysis of the sample showed that it contained about 8 percent of paraffinic constituent. Photomicrographs also showed the presence of traces of a crystal form thought to be characteristic of paraffinic hydrocarbons. The chief constituent showed a characteristic plate-crystal form.

Revised estimates of the relative quantities of the hydrocarbons in the crude petroleum are: 2-methylheptane, 0.5 percent; dimethylcyclohexane mixture distilling between 119.2 and 120.8°, 0.2 percent; octonaphthene boiling at 123.4°, 0.04 percent.

This work is completely reported in RP943 by Robert T. Leslie in the November number of the Journal of Research.

HEAT OF HYDROGENATION OF ETHYLENE

Extremely discordant values have been reported in recent years for the scientifically and industrially important thermodynamic quantity, the heat of hydrogenation of ethylene to ethane. From the value for the heat of combustion of ethylene recently obtained at the Bureau by Rossini and Knowlton and the values previously obtained by Rossini for the heats of combustion of hydrogen and ethane, a new value is deduced in RP933 in the Journal of Research for November, for the heat of hydrogenation of ethylene. The four earlier sets of calorimetric data leading to this quantity have been reviewed, and the following values deduced for $-\Delta H°$ at 25° C for the reaction, $C_2H_4(g) + H_2(g) = C_2H_6(g)$, in kilocalories per mole: Thomsen (1873–86), 32.3 ±1.5; Berthelot and Matignon (1893), 37.6 ±1.9; von Wartenberg and Krause (1930), 30.6 ±0.4; Kistiakowsky, Romeyn, Ruhoff, Smith, and Vaughan (1935), (a) 32.58 ±0.6; (b) 32.64 ±0.06; National Bureau of Standards (1931–36), 32.78 ±0.13. (In deducing the estimated uncertainties, no allowance has been made for possible "unknown" systematic errors.) It is concluded that the true heat of hydrogenation at 25° C lies in the immediate neighborhood of the last two values. The value of $-\Delta H°$ obtained by Teller and Topley and others, by combination of entropies computed statistically with the free energy determined experimentally, is apparently low by from 1.6 to 1.7 kilocalories per mole. The explanations of this discrepancy are briefly reviewed.

REFRACTIVE INDEX OF DISTILLED WATER AS A FUNCTION OF WAVE LENGTH

The validity with which dispersion equations can represent the refractive index of distilled water has been investigated at the Bureau as a preliminary to the use of such equations in adjusting and interpolating experimental data that are being used as a basis for extensive tables of the refractivity of water. For the purposes of these tests measurements were made at 20.00° C for 25 different wave lengths from 3889 to 7679 angstroms. All indices were determined by the method of minimum deviation using a water-jacketed hollow prism mounted in a stirred air bath on the table of a spectrometer. Equations having 4, 5, and 6 parameters were used and adjusted by least squares, and some of the difficulties in curve fitting to a few parts per million were investigated.

The results by use of different equations were examined and compared statistically and it is concluded that the Ketteler-Helmholtz equation in the approximate form

$$n^2 = a^2 - k\,\lambda^2 + \frac{m}{\lambda^2 - l^2}$$

is peculiarly suitable for the purpose of accurately representing the refractivity of water and its variation with wave length in the visible spectrum.

A paper by Leroy W. Tilton (RP934) in the November number of the Journal of Research should be consulted for a more complete account of this work.

COLOR TEMPERATURE OF TUNGSTEN-FILAMENT LAMPS

When a seasoned incandescent lamp is burned at constant voltage, its chromaticity is not quite constant but changes slowly toward yellow. This chromaticity is conveniently and customarily specified by color temperature, defined as the temperature which a completely enclosed space, such as in a furnace, would need to have in order to yield the same chromaticity by thermal radiation. The light output of the lamp also decreases.

An investigation was begun in 1930 by Deane B. Judd of the colorimetry section, with the primary purpose of discovering which of a number of types of tungsten-filament incandescent lamps was best suited for standards of color temperature. It was also expected that the study would show how much a working standard could be used before a check against a primary standard was advisable.

As a result of this investigation, which is described in RP937 of the Journal of Research for November, 400-watt projection lamps have been chosen as lamp standards of color temperature; this type of lamp was found to be as permanent as specially built photometric-standard lamps, and it is also a less expensive and more convenient type. The color temperature decreases when seasoned lamps of this type are burned at about 2,850° K by an average of less than one-tenth of a degree per hour. The rate of decrease is nearly proportional to the twenty-third power of the filament temperature, and is ascribed largely to the accumulation of the familiar brown deposit on the inside of the bulb. The effect of operating unseasoned lamps at constant voltage was found to be a rapid rise in color temperature extending over about half an hour, and amounting to nearly 100°K at 3,100° K.

DIAGRAM FOR ESTIMATION OF CHROMATICITY DIFFERENCES

Since the adoption in 1931 by the International Commission on Illumination of a standard colorimetric coordinate system, by far the majority of fundamental colorimetric specifications have been expressed in that system. A minor defect which is coming to be more keenly felt as the use of the system becomes more extended is the difficulty of interpreting differences in position on the standard mixture diagram in terms of degree and kind of chromaticity difference. The recent discovery (J. Research NBS 14, 41 (January 1935 (RP756)) of a projective transformation of the standard system in which the spacing accords better with visual estimates of chromaticity differences is a step toward remedying this defect, but since the correct spacing is so far only approximately known there is no new coordinate system that is sufficiently final to supersede the ICI system. However, it is possible to take advantage of what gains in spacing have already been made. In RP944 (November Journal of Research) by Deane B. Judd, the estimation of chromaticity differences has been facilitated by the preparation of a standard ICI mixture diagram showing by a group of ellipses the scales of perceptibility at the various parts of the diagram as closely as they are now known. The distances from the boundaries of the ellipses to their respective "centers" all correspond approximately to the same number (100) of "least perceptible differences." The estimation of nearest color temperature has been facilitated by the preparation of a standard ICI mixture diagram on which is shown a family of straight lines intersecting the locus representing the chromaticities of incandescent bodies as a function of their color temperatures; each straight line corresponds approximately to the locus of points representing chromaticities more closely resembling that specified by the color temperature at the intersection than that specified by any other color temperature.

TEMPERATURE COMPENSATION OF MILLIVOLTMETERS

An error occurred in this item on page 94 of Technical News Bulletin 234 (October 1936). The first sentence of the third paragraph should read:

"All the preceding treatments of the subject have failed to give an exact formula for temperature compensation and have neglected important practical requirements such as specified values for full-scale potential difference, damping resistance, and resistance of the millivoltmeter."

REDETERMINATION OF THE ATOMIC WEIGHT OF ALUMINUM

The atomic weight of aluminum has recently been redetermined by James I. Hoffman and G. E. F. Lundell at the National Bureau of Standards. In this determination of the atomic weight, weighed portions of the metal were converted to the hydroxide and sulphate, respectively. These were then heated until they were changed to the

oxide, Al_2O_3, which was finally ignited at 1,200 to 1,300° C. By this procedure, the atomic weight is related directly to that of oxygen.

Careful analyses showed that the metal contained only very small quantities of impurities and disclosed no gases in the highly ignited oxide. Proper corrections were made for the small amount of impurities in the metal, and special precautions were taken to prevent absorption of moisture by the ignited oxide during weighing.

The value for the atomic weight based on this work is 26.974 ± 0.002.

A complete account of this investigation will be published in the January 1937 number of the Journal of Research.

THERMAL EXPANSION OF LEAD-ANTIMONY ALLOYS

RP937 in the November number of the Journal of Research gives the results of an investigation by Peter Hidnert on the linear thermal expansion of cast lead-antimony alloys containing from 2.9 to 98.0 percent antimony. Observations were made at various temperatures between −12 and +200° C. and are shown in figures 3 to 5 of this publication.

The following conclusions were reached.

1. A majority of the curves obtained on cooling lie below the expansion curves obtained on heating. The deviations between these curves are particularly noticeable for the lead-antimony alloys containing up to 15 percent of antimony which were cast in a preheated steel mold and cooled slowly. The deviations are less noticeable for the alloys of higher antimony content which were cast either in a sand mold or a chill mold. It is probable that the deviations indicate a lack of equilibrium in the samples on account of the effect of the casting conditions or of the chemical composition.

2. The following equations give the relations between the coefficients of expansion and the chemical composition of the lead-antimony alloys investigated.

$$_{20}\alpha_{60} = (29.09 - 0.1789\ Sb)\ 10^{-6} \pm 0.3 \times 10^{-6} \quad (1)$$

$$_{20}\alpha_{100} = (29.31 - 0.1773\ Sb)\ 10^{-6} \pm 0.6 \times 10^{-6} \quad (2)$$

$$_{20}\alpha_{200} = (29.08 - 0.1786\ Sb)\ 10^{-6} \pm 0.3 \times 10^{-6} \quad (3)$$

$$_{100}\alpha_{20} = (29.44 - 0.1826\ Sb)\ 10^{-6} \pm 0.3 \times 10^{-6} \quad (4)$$

$$_{200}\alpha_{20} = (30.41 - 0.1941\ Sb)\ 10^{-6} \pm 0.3 \times 10^{-6} \quad (5)$$

In these equations, Sb represents the atomic percent of antimony between 4.8 and 97.0 atomic percent (2.9 to 95.0 percent of antimony by weight). In equations 1 to 3, inclusive, $_{20}\alpha_{60}$, $_{20}\alpha_{100}$ and $_{20}\alpha_{200}$ represent the average coefficients of expansion between 20 and 60°, 20 and 100°, and between 20 and 200° C., respectively. In equations 4 and 5, $_{100}\alpha_{20}$ and $_{200}\alpha_{20}$ represent the average coefficients of contraction between 100 and 20°, and between 200 and 20° C., respectively. The last term in each equation indicates the probable error of the coefficient of expansion. These equations show that the coefficient of expansion decreases linearly with increase in the atomic percent of antimony.

3. The densities of the lead-antimony alloys also decrease linearly with increase in the atomic percent of antimony.

4. The linear relations between the coefficients of expansion, or density, and the chemical composition (atomic percent) are typical of relations for other properties of binary alloys having structures composed of solid solution +eutectic.

5. The coefficients of expansion of the lead-antimony alloys cover a wide range of values. It is possible to select lead-antimony alloys that have approximately the same coefficients of expansion as iron, nickel, gold, copper, silver, aluminum, magnesium, and many of their alloys.

SOIL-CORROSION STUDIES, 1934

Supplementing the study under the direction of K. H. Logan, of the effect of soils on iron and steel pipe, a large variety of metals and alloys have been exposed to soils where serious corrosion of iron was known to occur. In all, about 9,000 specimens have been buried, 2,500 of which are still in the ground. At about 25 test sites all of the specimens have been removed and for this reason a report on the corrosion of nonferrous materials underground has been prepared, and will be found in the November Journal of Research (RP945).

While, in general, most of the nonferrous materials tested corrode less rapidly than does steel in most soils, no one material appears superior to all others under all soil conditions. To obtain the best results the user should determine which material is best adapted to his soil conditions.

The rates of corrosion of each material differ so greatly under different soil conditions that generalizations are of little practical value. In many soils light-weight ferrous materials will last so long that the use of better materials cannot be justified. Under other conditions the value of continuous trouble-

free service is sufficient to justify the use of a nonferrous material.

Soils high in soluble salts which are destructive to steel appear to cause the formation of corrosion products which protect lead from serious corrosion, but in a few soils lead pits badly and there is little evidence of the formation of such a protective coating.

In soils containing sulfides and sulfates, copper and high-copper alloys lose weight rather rapidly, and the protection rendered by the corrosion products is imperfect. Fortunately, the corrosion is nearly uniform. Brasses high in zinc show serious dezincification within a few years when exposed to certain soils. In most soils the corrosion of copper and brass seems to be nearly proportional to the duration of the exposure.

Specimens of zinc were placed in only five corrosive soils. In some of these the zinc corroded rapidly. In three of the soils the rate of penetration tended to increase with the duration of the exposure.

In a few soils aluminum and two of its alloys were unsatisfactory.

Tests in which dissimilar metals were interconnected showed serious acceleration of the corrosion of the anodic metal or alloy under several conditions. Under other conditions no galvanic action was indicated.

Two classes of nonmetallic pipe, one of wood fiber and the other of a mixture of portland cement and asbestos fiber, were not perfectly resistant to several of the soils. However, the methods of manufacture of these materials have been changed since the specimens were submitted.

TALC IN WHITEWARE

In recent years talc, as an ingredient of ceramic whiteware, has received the renewed interest of technicians and producers both in this country and abroad. Talc will act as a flux, reducing the amount of feldspar necessary to produce desired strength and structure, and will simultaneously decrease materially both the resistance to moisture expansion of porous bodies and the consequent crazing of the glaze. Since it enhances the fluxing effect of feldspar, nonporous ware may be produced at lower temperatures and, creases resistance to thermal shock. However, talc also decreases with viscosity of the feldspathic interstitial glass and shortens the temperature range in which feldspar changes from a state of incipient fusions to that of a comparatively fluid glass. Therefore, a body containing talc in amounts under approximately 40 percent has been found to "underfire" or "overfire" easily and to warp while in the kiln. In order to overcome these manufacturing difficulties and enable the producer to avail himself of the advantages resulting from the use of talc, an investigation was undertaken at the Bureau of the effects of different talcs in whiteware, and of the properties of compositions in which feldspar and talc were varied systematically.

The first study was of primary interest to producers of wall tile. The second study was more fundamental in character, dealing with the thermal decomposition of talc. In this, the third study, the following generalities may be based on the data obtained:

1. Feldspar is the predominant constituent influencing absorptivity, shrinkage, and the accompanying changes in strength and elasticity which take place during heating.

2. The possibility of developing vitrified bodies maturing below cones 8 to 10 appears remote for bodies made with a so-called high-lime talc.

3. In no case did a composition have a maturing range of more than "two full cones."

4. It was found that absorptivity, shrinkage, mechanical strength, and elasticity are closely interrelated.

SIMPLIFIED PRACTICE RECOMMENDATION FOR COARSE AGGREGATES

Simplified Practice Recommendation R163–36, Coarse Aggregates (Crushed Stone, Gravel, and Slag), now available in printed form, is based on an intensive study to develop standard sizes for coarse aggregates, by the Joint Technical Committee of Mineral Aggregates Associations. The committee includes representatives of the three principal associations of producers of mineral aggregates, namely, the National Crushed Stone Association, the National Sand and Gravel Association, and the National Slag Association.

As far back as 1920 and 1923, the American Society for Testing Materials published tentative specifications for mineral aggregates for highway construction, but these did not receive sufficient support to warrant their acceptance as standards.

From 1924 to 1930 the three associations of aggregate producers worked independently on the development of standard sizes, but it soon became evident that it would be necessary for them to coordinate their effects. Ac-

cordingly the Joint Technical Committee of Mineral Aggregates Associations was formed, and in 1930 undertook the development of joint recommendations.

For a long time specifications for concrete aggregates generally had been written in terms of square openings, while those for bituminous road work had been expressed chiefly in terms of round openings. With the gradual adoption of square openings by many State highway departments as well as many important standardizing bodies, the committee felt that the principal obstacle to the standardization of sizes was rapidly disappearing, and that the time was opportune to present the standards for consideration of the industry. Accordingly, the Bureau was requested to lend its assistance in establishing such standards by submitting them for approval and acceptance by producers, users, and others concerned.

In the printed pamphlet, tables 1 and 2 show the recommended sizes, and tables 3 and 4 the typical uses for each size. The sizes are based on sieves with square openings and they are divided into two groups, *A* and *B*, each of which is subdivided into "primary" and "combined and modified" sizes. Table 5 shows approximately equivalent round and square opening sizes in testing screens.

The recommended sizes have already found wide acceptance and form the basis for specifications of such organizations as the American Society for Testing Materials, The American Concrete Institute, the Federal Specifications Executive Committee, the American Association of State Highway Officials, and other organizations. The joint committee recognizes that the general use of these standards depends upon their acceptance by the consumer group, and it earnestly believes that their adoption will be of mutual benefit to both consumer and producer.

Careful consideration was given by the committee to the criticisms and comments which were received during the acceptance period, but it was felt that the objections offered were not of a serious nature and that the extent of nonacceptance was insignificant in comparison with the large number of acceptances received.

The printed edition of the recommendation contains, in addition to the simplified schedule of sizes of aggregates, a history of the project, and a list of acceptors of the program. This schedule became effective on June 10, 1936. Copies of R163–36 are obtainable from the Superintendent of Documents, Government Printing Office, Washington, D. C., at 5 cents each.

REVISED RECOMMENDATION COVERING ABRASIVE GRAIN SIZES

Simplified Practice Recommendation R118–36, Abrasive Grain Sizes, contains the first revision of this recommendation, which was adopted originally in May 1930 by a general conference of the industry, and made effective in September of that year. The recommendation is in the form of a table of allowable limits for the sizing of aluminum oxide and silicon carbide abrasives for polishing uses and for grinding wheel manufacture, and includes an example explaining the use of the recommendation.

The subject of standardization of grain sizes occupied the attention of the industry and allied interests for many years prior to the development of this recommendation. In 1919 the Grinding Wheel Manufacturers Association of the United States and Canada appointed a committee to study the subject, and the standards developed by that body received a fairly satisfactory degree of adherence during the next several years.

The increasing number of simplified practice recommendations successfully completed by various industries with the aid of the Department of Commerce, prompted requests from consumers of abrasive grains for size uniformity, which led to the formation of the Technical Committee on Grain Size Standardization and to renewed study of the whole subject. This committee met in December 1928 and tabulated analyses of each producer's product, and from this table drew up a set of specifications. The committee again met in December 1929, and slightly modified the specifications in the light of practical knowledge gained during the preceding year. Following this meeting the committee requested the Bureau to call a general conference of manufacturers and users of aluminum oxide and silicon carbide abrasive grains to consider the recommendations of the manufacturers. A conference of all interests was held in Washington on May 8, 1930, and after thorough discussion of the methods of screening abrasive grains and the varied results obtainable with the same sample under different conditions, the recommendations of the manufacturers were unanimously approved and made effective from September 1, 1930.

In October 1931, the standing committee of the industry, which had been

appointed to review the recommendation periodically, voted to continue the existing schedule of sizes for a further period, and the same action was followed in July 1934.

In April 1936 Henry R. Power, chairman of the standing committee, submitted some changes which had been proposed by the Technical Committee of the Abrasive Grain Association and approved by the association. These consist essentially of changes in wording to clarify the headings in the table of grain sizes and the accompanying example which explains the use of the recommendation, but they do not alter the recommended sizes. In addition, the word "sieve" has been substituted for the word "screen" in the table and notes.

The revised recommendation was made effective from September 1, 1936. Until printed copies are available, complimentary copies of the revision in mimeographed form may be obtained from the Division of Simplified Practice, National Bureau of Standards, Washington, D. C.

SIMPLIFICATION OF HACK-SAW BLADES

Simplified Practice Recommendation R90–36, Hack-Saw Blades, is the second revision of this program, originally adopted in 1928 by a general conference of the industry. The recommendation consists of tables showing dimensions, number of teeth per inch, and weight per gross of four types of hack-saw blades—tungsten alloy steel, double hardened, high-speed steel, and special alloy (all hard), in both hand and power sizes.

The need for simplification in hack-saw blades, due to the tendency toward unnecessary and increasing diversity, was recognized by the manufactures many years prior to the promulgation of this recommendation. With the Bureau's cooperation, a simplified list was developed which eliminated approximately 75 percent of existing sizes. This list was presented to a general conference of representative manufacturers, distributors, and users of hack-saw blades, and others concerned. The conference adopted the list by unanimous vote, and it was subsequently promulgated as Simplified Practice Recommendation R90–28.

After practically 1 year's experience in the operation of the recommendation, a modification of the schedule, together with the inclusion of two additional tables covering high-speed blades, was recommended. These changes were accepted by all interests and the revised program became effective July 1, 1929.

In April 1936, the chairman of the standing committee stated that the industry had approved a new and more complete schedule of standards for hack-saw blades, and suggested that SPR R90–29 be revised. The revised tables include a new type of blade known as "special alloy", shown in table 4. Double heat-treated blades, formerly comprising part of the standard tungsten group, are now given as a separate type, in table 2, entitled "Double-Hardened Blades." In addition, the tables have been extended to include four new dimensions and weight per gross of blades listed.

Following approval by all members of the standing committee, the proposed changes were submitted to the industry, and a gratifying large number of acceptances were received, evidencing a high degree of support for this program.

The printed edition of the revised recommendation will contain, in addition to the schedule of sizes of hack-saw blades, a history of the development of the project, personnel of the standing committee, and a list of acceptors. Until printed copies are available, free mimeographed copies of the revision may be obtained from the Division of Simplified Practice, National Bureau of Standards, Washington, D. C. The effective date of the revised schedules was October 1, 1936.

NEW AND REVISED PUBLICATIONS ISSUED DURING OCTOBER 1936

Journal of Research [1]

Journal of Research of the National Bureau of Standards, vol. 17, no. 4, October 1936 (RP925 to RP932, inclusive). Price 25 cents. Obtainable by subscription.

Research Papers [1]

[Reprints from the July and August 1936 Journal of Research]

RP900. Measurement of flame velocity by a modified burner method. Francis A. Smith and S. F. Pickering. Price 5 cents.

---

[1] Send orders for publications under this heading only to the Superintendent of Documents, Government Printing Office, Washington, D. C. Subscription to Technical News Bulletin, 50 cents per year; Journal of Research, $2.50 per year (United States and its possessions, and Canada, Cuba, Mexico, Newfoundland, and Republic of Panama); other countries, 70 cents and $3.25, respectively.

RP903. Determination of the Brinell number of metals. Serge N. Petrenko, Walter Ramberg, and Bruce Wilson. Price 5 cents.
RP905. Drop of potential in the metallic electrodes of certain electrolytic cells. Chester Snow. Price 5 cents.
RP906. Term analysis of the first spectrum of vanadium (V I) William F. Meggers and Henry Norris Russell. Price 10 cents.
RP907. Experimental study of the scour of a sandy river bed by clear and by muddy water. Chilton A. Wright. Price 5 cents.
RP908. Joliet reference gas meter. Howard S. Bean, M. E. Benesh, and Frank C. Witting. Price 10 cents.
RP909. Soluble decomposition products in aged vegetable-tanned leathers. Joseph R. Kanagy. Price, 5 cents.
RP911. The system K_2O–PbO–SiO_2. R. F. Geller and E. N. Bunting. Price, 5 cents.

Simplified Practice Recommendations[1]

R163–36. Coarse aggregates (crushed stone, gravel, and slag). Price, 5 cents.

Commercial Standards[1]

CS59–36. Woven dress fabrics—testing and reporting. Price, 5 cents.

Technical News Bulletin[1]

Technical News Bulletin No. 234, October 1936. Price, 5 cents. Obtainable by subscription.

MIMEOGRAPHED MATERIAL

Letter Circulars

Letter Circulars are prepared to answer specific inquiries addressed to the National Bureau of Standards, and are sent only on request to persons having definite need for the information. The number of copies available is limited. The Bureau cannot undertake to supply lists or complete sets of Letter Circulars or to send copies automatically as issued.

LC476. Bibliography on spark plugs.
LC477. Sound absorption coefficients of the more common acoustic materials. (Supersedes LC452.)

Technical Information on Building Materials

The supply of these notes, each of which consists of 3 or 4 pages giving the important facts on some one aspect of the properties or use of building materials, is necessarily limited. Their distribution will be confined to Government officials concerned with building projects, and to architects, engineers, and home builders. Requests should make clear the actual need for the information at the time of writing. Letters should be addressed to the Division of Codes and Specifications, National Bureau of Standards, Washington, D. C. The following notes have been issued since the list published in the October 1936 number of the Technical News Bulletin:

TIBM–37. Commercial masonry cement investigations.
TIBM–38. Mortar and brick properties and their relation to bond.
TIBM–39. Types of decks adapted to bituminous built-up roofing.
TIBM–40. Materials used in bituminous built-up roofing.

RECENT BUREAU ARTICLES APPEARING IN OUTSIDE PUBLICATIONS[2]

Physical properties of the zinc phosphate cements. George C. Paffenbarger and Wilmer Souder. Proc. Ninth Int. Dental Cong. (Urban and Schwazenberg, Vienna, Austria) 347 (1936).
A progress report on denture base material (1935). W. T. Sweeney and Irl C. Schoonover. (J. Am. Dental Assn. 213 E. Superior St., Chicago, Ill.) 22, 1498 (August 1936).
The precisions of knock rating. Donald B. Brooks. SAE Journal (Society Automotive Engineers, 29 W. 39th St., New York, N. Y.) 39, no. 4, 22 (October 1936).

[1] Send orders for publications under this heading only to the Superintendent of Documents, Government Printing Office, Washington, D. C. Subscription to Technical News Bulletin, 50 cents per year; Journal of Research, $2.50 per year (United States and its possessions, and Canada, Cuba, Mexico, Newfoundland, and Republic of Panama); other countries, 70 cents and $3.25, respectively.

[2] These publications are not obtainable from the Government. Requests should be sent direct to the publishers.

The emergence of the cicada. W. W. Coblentz. Scientific Monthly (Grand Central Terminal, New York, N. Y.), 43, 239 (September 1936).

Methode pour determiner la distribution de l'energie dans l'extreme ultraviolet solaire. W. W. Coblentz and R. Stair. Annales de l'Institut d'Actinologie (Paris, France) 10, no. 6 (August 1936).

Synthetic resins from petroleum. Gordon M. Kline. Modern Plastics (425 Fourth Ave., New York, N. Y.) 14, no. 1, 34 (September 1936).

The use of nonferrous metals underground. K. H. Logan. Oil and Gas J. (Tulsa, Okla.) 35, no. 9, 137 (September 24, 1936).

U. S. GOVERNMENT PRINTING OFFICE: 1936